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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

ANNUAL INVESTIGATIVE REPORT FOR 1931 AND

PROGRAM FOR 1932

CENTRAL STATES FOREST EXPERIMENT STATION



Branch of Research

U. S. Forest Service - Department of Agriculture

CENTRAL STATES FOREST EXPERIMENT STATION

ANNUAL INVESTIGATIVE REPORT FOR 1931

AND PROGRAM FOR 1932

(Calendar Years)

CENTRAL STATES REGION

Ohio
Indiana
Illinois
Iowa
Missouri
Western Kentucky
Western Tennessee
Northern Arkansas

3271
4-5

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CENTRAL STATES FOREST EXPERIMENT STATION

Offices: Ohio State University, Columbus, Ohio

FOREST SERVICE

*Willis M. BakerDirector
John T. AutenSilviculturist
Leonard F. KelloggAssociate Silviculturist
Ralph K. DayAssistant Silviculturist
John G. KuenzelJunior Forester
Ruth G. EntSenior Clerk
Charlotte HustonJunior Clerk-Stenographer

A. G. Chapman	Field Assistant	Morris A. Huberman
Oliver D. Diller	" "	Elwood P. Schmink
W. M. Beckert	" "	C. R. Cochran
Geo. K. Schaeffer	" "	C. Paul Shull

COLLABORATORS - 1931

Edgar N. Transeau, Botany Department, Ohio State University
Homer C. Sampson, Botany Department, Ohio State University

BUREAU OF ENTOMOLOGY

Ralph C. Hall Assistant Entomologist

William H. Cummings..Field Assistant..Gordon Z. Rayner

*Appointed September 18, 1931 to fill vacancy caused by resignation
of E. F. McCarthy.

COOPERATION

Acknowledgement is made of helpful cooperation from many sources. Ohio State University provides headquarters for the Station, and the Departments of Botany, Horticulture, Entomology, Chemistry, and Soils render valuable assistance in many ways. Cooperative studies are being carried on with the Forestry and Animal Husbandry Departments and the Superintendent of Farms of Purdue Agricultural Experiment Station, and with the Forestry and Botany Departments of Iowa State College.. The State forestry organizations of the region, especially in Indiana, Illinois, and Ohio; the Extension Foresters of these States; the State Entomologists of Ohio, Kentucky, and Michigan; and many other organizations and individuals within the region, mentioned under the project reports, have assisted the Station in many ways. This cooperation is sincerely appreciated.

(Over)

CENTRAL STATES FOREST RESEARCH COUNCIL

1932

C. V. Anderson, Pres. T. L. Wheeler, Vice-Pres. W. M. Baker, Sec.

OHIO

C. Vivian Anderson, Insurance, Union Trust Bldg., Cincinnati.
C. A. Dyer, Agricultural Legislative Agent, Southern Hotel, Columbus.
Edmund Secrest, State Forester, Wooster.
Alexander Thomson, Champion Coated Paper Company, Hamilton.
Dr. E. N. Transeau, Botany Department, Ohio State University, Columbus.

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Charles H. Barnaby, Lumberman, Greencastle.
Dr. Stanley Coulter, Conservation Commission, Indianapolis.
Dr. J. H. Skinner, Purdue Agri. Exper. Sta., Lafayette.
Tom L. Wheeler, Editor, Indiana Farmer's Guide, Huntington.
Ralph Wilcox, State Forester, Indianapolis.

ILLINOIS

William T. Culver, Jas. D. Lacey & Co., 231 S. LaSalle St., Chicago.
W. F. Lodge, Izaak Walton League, Monticello.
R. B. Miller, Department of Conservation, Springfield.
Earl C. Smith, Illinois Agri. Asso., 608 S. Dearborn St., Chicago.
Dr. William Trelease, Botany Dept., Univ. of Illinois, Urbana.

IOWA

Chas. E. Hearst, Iowa Farm Bureau, 410 Observatory Bldg., Des Moines.
G. B. MacDonald, Forestry, Dept., Iowa State College, Ames.

MISSOURI

R. W. Brown, Missouri Farm Bureau, Jefferson City.
E. E. Pershall, Moss Tie Company, St. Louis.
Paul C. Stark, Nurseryman, Louisiana.

KENTUCKY

Chas. F. Huhlein, Bernheim Estate, 139 S. First St., Louisville.
W. E. Jackson, Jr., State Forester, Frankfort.

TENNESSEE

James O. Hazard, State Forester, Nashville.

CENTRAL STATES FOREST EXPERIMENT STATION

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GENERAL

The Importance of Forestry in the Central States, and the necessity for a comprehensive conservation program enthusiastically supported by awakened public opinion, is not yet fully appreciated by the people of the region, nor by the forestry profession of the nation. Until this situation is remedied by education, progress will necessarily be slow.

During the past era of constant industrial and agricultural expansion, this prosperous Central States region has given little thought to its extensive degraded and impoverished areas, or to the loss of its resources exhausted by exploitation. Gradually, however, the public is becoming conscious of the necessity for an extensive program of restoration, to safeguard the public interests. The establishment and conservation of forests on the poorer, non-agricultural lands is becoming recognized as essential to the solution of the growing problems of flood and erosion control, water conservation, utilization of abandoned waste lands, conservation of wild life, and public out-of-door recreation. These forest values further emphasize the importance of forestry to a region which now imports more than four-fifths of the wood and lumber used, at a cost of hundreds of millions of dollars annually.

Regional Organization and Cooperation. Probably no other region has been more handicapped in the past by public indifference to forestry. Even now many organizations and individuals who should be vitally interested still fail to appreciate the full significance of the movement. The Federal Forest Service, with its interests chiefly centered in those regions supporting National Forests, has been forced to concentrate its work and its support elsewhere. In each of the several states more or less progress has been made by local agencies, but until recently there has been little regional coherence to the forestry and general conservation movement.

In 1930, the recognized need for team work and cooperative effort found expression in the creation of the Central States Forestry Congress, with the first meeting held in Indianapolis in December, 1930. This organized effort has prospered, and the second Congress, held in Cincinnati in December, 1931, presented a splendid program, was well attended, and created much interest and favorable comment.

This and other efforts to advance forestry in the Central States demand and deserve the support of the forestry profession and conservation organizations everywhere. No national program can progress as it should without the intelligent backing of public opinion in the populous region of the Central States. It is here that the agricultural interests, so influential in public affairs, must be convinced that the forestry program deserves their support. The national problems of land erosion and flood control are of major importance in this region. Nowhere is the conservation of wild life so dependent upon the establishment and protection of woodlands. Forestry in the Central States can no longer be ignored.

Correlation of Research. It is recognized that all branches of forest research must be advanced rapidly, lest the progress of forestry work be held up by lack of knowledge and facts, as indeed is already the case in many sections of the country. The Central States Forest Research Council, by whose initiative the Forestry Congress was founded, realizes that correlation of research and coordination of effort are necessary to avoid duplication of work and waste of time. Accordingly, at its meeting in Cincinnati on December 3, 1931, this Council authorized the appointment of a committee composed of one member from each State, to compile a list of all forestry investigations and studies which are now being carried on by the various agencies in the region. When completed, this list of organizations and their projects will form the basis of a comprehensive regional program of forest research, to be expanded and strengthened where necessary, looking ahead to the needs of the future, with the work of all agencies efficiently coordinated through cooperation.

Organizations which have not yet submitted a list of their forestry investigations, as requested by this committee, are earnestly invited to do so.

Research Council Meetings. Two meetings of the Central States Forest Research Council were held during 1931, in St. Louis on May 26 and in Cincinnati on December 3. Major R. Y. Stuart, Forester, U. S. Forest Service; H. Basil Wales, Assistant Regional Forester of Milwaukee; and E. M. Bruner, District Forest Inspector of Louisville were guests at the St. Louis meeting; E. N. Munns of the Branch of Research and Fred Morrell, Chief of the Branch of Public Relations, U. S. Forest Service, Washington, and Mr. Bruner attended the Cincinnati meeting.

C. Vivian Anderson of Cincinnati was elected President of the Council; Tom Wheeler of Huntington, Indiana, Vice-President; and W. M. Baker of Columbus, Secretary.

ADMINISTRATION

Personnel. There have been several changes in and additions to the staff of the Station during 1931. Director E. F. McCarthy resigned on September 1, and his vacancy was filled by the appointment of Willis M. Baker. McCarthy had directed the work of the Station since its establishment in 1927, and his loss will be keenly felt. On June 1, the U. S. Bureau of Entomology assigned Dr. R. C. Hall to the Station as Assistant Entomologist to conduct studies of the locust borer. In July, John G. Kuenzel was appointed Junior Forester. Miss Charlotte Huston was appointed to the clerical force in July to fill the vacancy caused by the resignation of Miss Nimocks.

Public Relations and Education. The relative isolation of the Central States Forest Experiment Station in a section of the country rather remote from the Regional offices and the other activities of the U. S. Forest Service, have made it necessary for the Station to cooperate closely with the various local forestry agencies in many ways and to engage in the general forestry affairs of the section to a considerable extent.

During 1931 the Station was represented at nine forestry and conservation meetings throughout the region, and talks were given by members of the staff on five occasions. The Indiana Forestry Department was assisted in preparing a forestry exhibit for the Governor's Conference at French Lick. Photographs were furnished to illustrate the publication of the 1930 proceedings of the Central States Forestry Congress, and assistance was given in the preparations for the 1931 meeting. A radio talk was given over Station WAIU - Columbus. Over 300 photographs were added to the Station's collection during the year. Twelve forestry lectures were given to the forestry students of Ohio State University, in accordance with a cooperative agreement, and two lectures were held at the forest school of Purdue University. A progress report of the Station's activities was prepared in November and sent to a revised and enlarged mailing list of 400 interested forestry organizations and individuals, chiefly within the region.

Offices and Laboratory. When the Station was established in Columbus in 1927, Ohio State University provided office space in Room 209 of the Horticulture Building, under a cooperative agreement. Relations with the University have been very cordial and helpful to the Station. In addition to the offices, a garage on the Campus was set aside for storage of the Station's automobiles, and a forest litter laboratory was provided by the Chemistry Department. Recently the Botany Department allotted space for a small experimental nursery. The increases in the staff of the Station, and the addition of more equipment, together with the demands of the work, have made it necessary to request more space for offices and laboratories. This request is now under consideration by the University authorities.

DISTRIBUTION OF EXPENDITURES - 1930-1932

<u>PROJECT</u>	<u>Fiscal Year 1931</u> 7-1-30 to 6-30-31	First Half of	Estimated for
		<u>Fiscal Year 1932</u> 7-1-31 to 12-31-31	<u>Second Half of</u> <u>Fiscal Year 1932</u> 1-1-32 to 6-30-32
M-1 Forest Litter	\$10,040.99	5,485.32	3,965.00
Fp-1 Plantations	8,810.86	5,698.31	4,195.00
M-2 Woodland Grazing* (Formerly Pa-1)	7,154.58	3,722.54	3,940.00
ME-2 Oak Yield (Formerly TS-12)	1,820.52	94.06	1,035.81
Yellow Poplar (Formerly TS-375)	1,439.15	436.87	0
Extensive Revision	1,251.28	1,304.99	0
Type Study (Formerly T-1)	<u>487.45</u>	<u>82.10</u>	<u>0</u>
TOTAL....	\$31,004.83	16,824.19	13,135.81
Locust Borer Investi- gation (Bureau of Entomology)	676.30	3,449.81	3,010.19

*During 1931 the Purdue Agricultural Experiment Station contributed \$2,179.12 to the Woodland Grazing Project in time and equipment.

DISTRIBUTION OF TIME - 1931

Total Days' Work - Permanent Staff	= 1,916
" " " - Temporary Assistants	= 1,107
TOTAL.....	<u>3,023</u>

Field Work by States

	Days' Field Work
Ohio	582
Indiana	425
Illinois	20
Missouri	6
Kentucky	53
Michigan	39
TOTAL	<u>1,125</u>

RESEARCH INVESTIGATIONS

FOREST LITTER PROJECT M-1

(Dr. John T. Auten)

Soil Porosity. The study of the relation of forest litter to soil porosity, begun by Dr. Auten in 1930, brought to attention such significant differences between old-growth forest and field sites, that investigations were continued during 1931 to include tests of soils of second-growth woods -- grazed and ungrazed -- and of forest plantations.

Approximately 1,600 soil samples were taken from 22 old-growth forest sites in Ohio, Indiana, Illinois, and Michigan; from 36 second-growth woods in Ohio, 9 of which represented typical grazed and ungrazed conditions; and from 13 forest plantation sites in Ohio and Illinois. Nearly 1,000 field tests for water absorption were made on these same sites.

From the 1930 work it was shown that the upper 9-inch horizon of field soils averaged 15% heavier than the corresponding layers of soils under virgin or old-growth forest conditions. Field and laboratory tests made during 1931 have demonstrated that the upper 3-inch layer of average field soils is 43% heavier than the similar layer of average forest soil; the second 3-inch horizon of field soils averages 12% heavier, and the third 3-inch horizons are practically equal in weight. The tests of water absorption capacity have demonstrated that forest soils absorb water much more readily than do cultivated or field soils. These tests were made at depths of 1, 3, and 8 inches below the soil surface, with the top layer of duff and litter removed from the forest soils. Under old-growth forest conditions, the soils at 1-inch depth absorbed water 47 times as readily as did the average field soils; at 3-inch depths the ratio was 15 to 1, and at 8-inch depths nearly 2-1/2 to 1, in favor of the forest soils.

Similar tests have demonstrated very conclusively that second-growth forest soils retain their porosity and water absorption capacity to a high degree when complete forest cover is reestablished and maintained, and that field soils regain much of their original forest porosity in about 25 years after forest plantations have been established. On the other hand, the soils of heavily grazed woods lose their porosity until they closely resemble those of open fields.

The results of this study are a very definite contribution to the solution of the important problems of land erosion, water conservation, and flood control. They are also significant in the problem of reforestation of abandoned fields and clearings. The manuscript of the completed report has been submitted to Washington for publication.

Relative Volumes of Water Absorbed per Minute by
Virgin Woods and Adjacent Field Soils at Various Depths

Woods	Field	Woods	Field	Woods	Field
205 c.c.					
		72.0 c.c.			
	4.0 c.c.		5.0 c.c.	9.0 c.c.	4.0 c.c.
1 Inch Depth		3 Inch Depth		8 Inch Depth	

Relative Volumes of Water Absorbed per Minute
by Plantation and Adjacent Field Soils

Woods	Field	Woods	Field
110 c.c.			
	8.1 c.c.		
1 Inch Depth		13.1 c.c.	3.3 c.c.
		8 Inch Depth	

Relation of Base Exchange Calcium and Magnesium to Forest Litter.

The base exchange calcium and magnesium comparisons of forested and cultivated soils are not yet completed, but sufficient data are at hand to indicate the enormous losses of the alkaline-earth metals, following the clearing of forest soils for cultivation. This loss may have a direct bearing on the possibility of successful reforestation of abandoned fields. The loss of calcium and magnesium, together with the decreased porosity and capacity for water absorption, may be an explanation of the difficulty ordinarily encountered in establishing hardwoods on worn-out soils that formerly grew good stands of the better species. On such sites it may be found necessary to use less lime-exacting species, and those which endure drought conditions, at least until the site becomes improved by the establishment of forest cover. It is planned to complete laboratory investigations of the base exchange studies during 1932.

Study of Site Requirements of Planted Species. In order to bring to completion certain phases of the Station's work, and to secure information that is urgently needed by the forestry profession, it appears both advisable and timely to concentrate next on a phase of the litter study that has so far received little consideration; namely, a study of the site requirements of planted species. By coordinating this investigation with Kellogg's study of plantations, it may be possible to correlate certain site characteristics with growth and yield. Such a study in pure plantations of one species will lead logically and gradually to an understanding of the more complex mixtures of natural stands, and the important functions of forest litter.

The results of the study of site requirements of planted species should prove to be of great value to forest planters, and to the foresters sponsoring planting programs in the Central States. At present, there are too many failures because of species being planted on sites to which they are poorly adapted. In order to take advantage of the growth and yield plots already established by Kellogg, it is planned to start the 1932 program with the study of site requirements of planted black walnut.

PLANTATION PROJECT Fp-1

(L. F. Kellogg)

Black Walnut

Much of the computational work on plantation black walnut volume and yield tables was completed by Kellogg during a two month detail to Washington, where he had the use of the equipment and trained clerical help in the office of Forest Measurements. This work was interrupted late in April by preparations for the field season devoted to the black locust study, although a few additional plots of black walnut were established in Ohio during the summer. During the fall and winter of 1931 the walnut computation was resumed. A regional map and county base maps for Iowa, Illinois, and Ohio have been prepared to show the location of plots within the region. Early in January, 1932, Kellogg was again given a detail to Washington, and it is expected that this project will be completed, ready for publication, by spring.

Black Walnut Volume Tables. Two additional walnut tables were completed during the year. The Office of Forest Measurements, Washington, D. C., constructed a table of board foot content by the Scribner rule to an 8-inch top, and Kellogg constructed a board foot table by the Scribner rule to a 10-inch top. The first table gives the contents of trees by a fair log rule under improved utilization, and the second table approximates the closest utilization that one ordinarily finds today.

Volume tables are not yet available for publication, but they can be supplied for use by application to the Station. Following is a complete and final list of these tables:

Table

VOLUME TABLES PLANTATION BLACK WALNUT

TABLE	UNIT	BASIS	DIAMETER CLASSES	HEIGHT CLASSES
Total Volume	Cu. Ft. Entire Stem	Trees: 400	Inches: 1 to 22	Feet: 10 to 90
Merchantable Volume with bark	Cu. Ft. to a 4" top	345	5 to 22	20 to 90
International 1/8" kerf	Bd. Ft. to a 5" top	256	7 to 23	30 to 90
Scribner	Bd. Ft. to an 8" top	153	10 to 23	50 to 90
Scribner	Bd. Ft. to a 10" top	90	13 to 23	50 to 90

Site Classification of Plantation Black Walnut. In the assignment of site classification to the black walnut plots, the age of 50 years was chosen. It was found that the site index of the plots varied from 35 to 84 feet; i. e. at 50 years of age the average heights of the dominant walnut stands in these plots ranged from 35 feet to 84 feet. This spread allowed the recognition of five sites in plantation black walnut as follows:

Site	Ht. of Av. Dom. Stand at age 50 years. Feet
I	80
II	70
III	60
IV	50
V	40

The many State and Extension foresters who have cooperated with this Station may wonder how the walnut plantings in their respective states classify in respect to this system. The classification of 205 plots is presented in the following table. This cannot be taken as an impartial index of the site quality of each state for the growth of walnut, but it does indicate the spread of the data taken in each state. Many plantings which were understocked or partially cut, and thereby unsuited for the field study, may have been of better site than those recorded. The variation of site for walnut appears to be so local in character that it is impossible to prepare a zone map of site quality for this region.

DISTRIBUTION OF YIELD PLOTS BY STATES AND SITE
PLANTATION BLACK WALNUT

STATE	Site Class					TOTAL
	At Age 50 years					
	Number of Plots					
	I	II	III	IV	V	
	No.	No.	No.	No.	No.	No.
Illinois	4	26	27	27	2	86
Indiana	-	4	9	7	5	25
Iowa	2	9	26	30	13	80
Kentucky	1	-	1	-	1	3
Missouri	-	-	1	-	-	1
Ohio	-	1	2	2	5	10
TOTAL	7	40	66	66	26	205

Black Walnut Yield Tables. The basic black walnut yield tables have been finished. From these tables those for partial stands will be derived. Following is a list of the tables which have been cross-checked, checked against individual plots, and completed:

1. Average total height of dominant and codominant trees.
2. Total basal area -- entire stand.
3. Average basal area per tree -- entire stand.
4. Average diameter breast high -- entire stand.
5. Total numbers of trees per acre -- entire stand.
6. Total volume in Cubic Feet per acre -- entire stand.

Recent work has been directed towards tables for the present merchantable portion of walnut stands; i.e. trees 13 inches in diameter and over. The three tables which have been completed are:

1. Total basal area -- stand 13 inches D. B. H. and over.
2. Average diameter per tree -- stand 13 inches D. B. H. and over.
3. Number of trees per acre -- stand 13 inches D. B. H. and over.

It is planned to produce similar tables for the stand 7 inches D. B. H. and over (International board foot lower limit), and for the stand 4 inches D. B. H. and over (cordwood size).

Black Walnut Litter. Arrangements were again made with the School of Forestry of Iowa State College at Ames, Iowa, to secure measurements of the progressive fall of leafage in the black walnut planting north of the Campus. Through the helpful cooperation of Dr. J. M. Aikman of the Department of Botany, this work was carried on by a graduate student, Mr. Edsko Dyksterhuis, from June 14 to August 25. Mr. A. F. Dodge, a student in the Forest School, made the collections and weighings through September and October.

The following table contains the data expressed on a per acre basis:

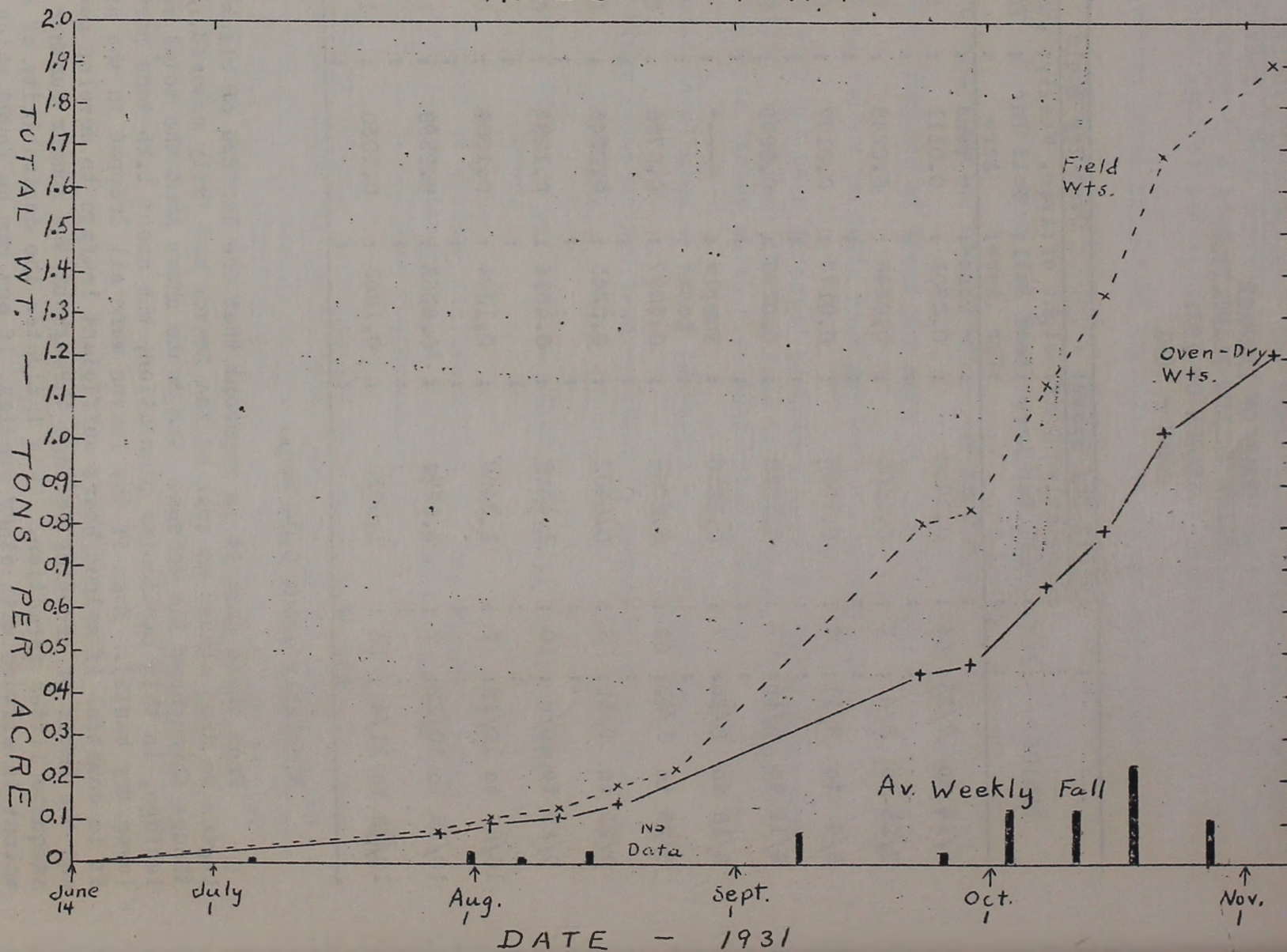
FALL OF LEAFAGE
BLACK WALNUT PLANTATION
SEASON OF 1931
AMES - IOWA

PERIOD	DAYS	Field Dry Basis:		Oven Dry Basis	
		Cumulative Leaf:Weight of:		Aver. Weekly: Cumulative	
		Fall Per Acre	Leaf Fall:	Fall Per	Fall Per
			Per Acre:	Acre	Acre
		- Tons -	- Tons-	- Tons -	- Tons -
6/14 to 7/28:	44 :	0.0740	0.0701 :	0.0111	0.0701 :
7/28 to 8/4 :	7 :	0.1105	0.0248 :	0.0248	0.0949 :
8/4 to 8/11:	7 :	0.1358	0.0177 :	0.0177	0.1126 :
8/11 to 8/18:	7 :	0.1838	0.0299 :	0.0299	0.1425 :
8/18 to 8/25:	7 :	0.2210	Sample :	-----*	-----
			Lost* :		
8/25 to 9/23:	29 :	0.8086	0.3097 :	0.0755	0.4522 :
9/23 to 9/29:	6 :	0.8402	0.0245 :	0.0245	0.4767 :
9/29 to 10/8 :	10 :	1.1318	0.1816 :	0.1297	0.6583 :
10/8 to 10/15:	7 :	1.3498	0.1304 :	0.1304	0.7887 :
10/15 to 10/22:	7 :	1.6774	0.2368 :	0.2368	1.0255 :
10/22 to 11/4 :	13 :	1.9030	0.1855 :	0.1030	1.2110 :

*Probably about 0.04 tons.

From these data it is apparent that the leafage of black walnut begins to drop almost as soon as the leaves are fully matured, and continues throughout the season. The table shows that the total fall of leafage, in this particular plantation, was about 1.25 tons per acre (oven dry basis). Even if the leaves were all dropped in the autumn, it is doubtful if walnut bears sufficient leafage to develop good litter, and the habit of dropping foliage throughout the summer further prevents adequate litter formation. This indicates the desirability of growing walnut in mixture with other species, if any can be found which will grow satisfactorily with walnut.

CUMULATIVE FALL OF LEAFAGE BLACK WALNUT PLANTATION AMES — IOWA



Black Locust

At the beginning of the 1931 field season, a study of growth and yield of planted black locust, similar to the black walnut study now being completed, was begun by Kellogg. This project was especially timely, since it permitted of cooperation with the U. S. Bureau of Entomology, which assigned Dr. Ralph C. Hall to the Station in June to initiate a comprehensive investigation of the locust borer. This joint study was conducted economically, and with every indication of valuable returns.

During the field season two parties were used, each party composed of two field assistants employed by the Station to secure plantation and yield data, and one field assistant in Entomology who took data on the locust borer. Supervision was given to both parties by Kellogg and Hall, who worked slightly ahead of them, scouting for plantations.

Black Locust Yield Plots. Practically the entire season was spent in locating and establishing yield plots. Great assistance was contributed by State Foresters Secrest of Ohio and Wilcox of Indiana, in providing lists of plantations located within their respective States. Foresters R. B. Miller and L. E. Sawyer offered to provide a similar list for Illinois.

The field parties completed work in Ohio, and late in August moved into Indiana, where the balance of the season was spent in Clark, Jefferson, and Ripley Counties. Locust plantations of the University of Michigan on the Saginaw Forest were also visited, but no plots were taken since the age and site classes were already well represented in the data at hand. Altogether, 169 black locust plots were established, of which 139 were in Ohio and 30 were in Indiana. In addition, there were taken during the season 10 black walnut, 2 yellow poplar, and 1 ash plantation plots; and also 10 plots of the following species planted in mixture with black locust: 1 black cherry, 1 black walnut, 4 catalpa, 1 osage orange, 1 silver maple, 1 white ash, and 1 white pine. These mixed plots are valuable to shed light on the influence of locust on other species, and the possible influence of mixtures on the locust borer damage. All plots were so established and recorded that they may be readily relocated at any time for further measurements and observations.

Black Locust Stem Measurements. Although the 1931 field crews were equipped and prepared to secure stem measurements of black locust found in cutting operations, for use in volume tables, only 2 trees were measured during the season. Inquiries for locust cutting operations were broadcasted, but none was reported. Apparently it will be necessary to resort to climbing, a slow and costly procedure, in order to secure volume data for black locust in this region.

Black Locust - Nitrogen Study. In the course of the field work on the black locust plantation project, the Station cooperated with Mr. A. G. Chapman of the Department of Botany, Ohio State University, in the collection of several hundred soil samples in locust plantings of different ages on different soils. It is Mr. Chapman's plan to base his Doctor's thesis on the nitrogen relationships of black locust, with consideration to soil types. By correlating his study with those of plantation yield and locust borer damage, Mr. Chapman may uncover valuable facts on the relation of nitrogen fixation and site. Data at hand has indicated that the formation of root nodules on locust is not influenced by soil acidity, but is largely prevented in soils badly compacted by grazing.

Scotch-Red-White pine Plots. The permanent sample plot of Scotch pine, planted in 1929 at the Boy Scout Camp on Olentangy River above Columbus, was remeasured during 1931 to observe the damage done by the 1930 drought, and recovery from rabbit injury in the winter of 1929-30. It was gratifying to find little evidence of drought injury, and practically complete recovery from the rabbit damage. Even those pines from which the leaders and foliage had been severely eaten, produced new buds and needles and retained life and position. No additional rabbit damage was noticed, and the trees were thrifty in appearance.

Red pine and white pine plantations started nearby in the spring of 1930 showed little evidence of drought or rabbit injury, and had a survival of 94 and 92 per cent respectively.

1932 Plans for Black Locust Plantation Study. It is planned to continue the study of black locust during 1932. Two field crews will be used for the volume and yield phase, one to complete the location and establishment of locust plots throughout the region, and the other to secure stem measurements for the volume tables. As in 1931, the project will be carried on cooperatively with the locust borer investigation of Dr. Hall.

WOODLAND GRAZING PROJECT M-2 (Formerly Pa-1)

(Ralph K. Day)

The livestock industry is of major importance to agriculture in the Corn Belt. Every available acre is devoted to raising grain or hay, with the resulting serious reduction of pasture land. On many farms the woods provide the only pasture available. Throughout the Corn Belt it is estimated that there is one animal unit for every 1.7 acres of farm woods.

Under such conditions of overgrazing, the livestock receive little actual forage from the woods, and many such areas have degenerated into mere feed, or dry, lots. Moreover, fully fifty per cent of the farm woods have been so badly damaged by overgrazing that they are no longer capable of producing forest products. The complete absence of young growth to take the place of the older trees as they die or are cut down, is gradually converting grazed woodlands into open pastures. If the present system of live stock management is continued, the farm woods will eventually disappear, a situation which threatens to have serious economic, sociologic, aesthetic, and biotic effects on community and public welfare.

The solution of the grazing problem is regarded as the first essential objective leading to the development of plans for the proper management of farm woodlands in this region. All of the permanent grazing plots located to date have been selected with consideration of their adaptation to studies of woodland management. The field work of the grazing study will eventually be limited to the periodic remeasurements of established plots; it will then be possible to devote some attention to the more comprehensive study of management of the farm woods. Without additions to the Station's staff, this may not be possible for several years, but it is mentioned at this time to illustrate the trend of the Station's program in respect to the farm woods.

Reconnaissance Phase. When the woodland grazing project was initiated in 1928, it was recognized that an extensive reconnaissance survey was needed to provide information regarding the scope of the problem. This survey showed that the most serious situation existed within the Corn Belt region, and that the study logically divided into the several phases outlined in this report.

Field work on the Reconnaissance Phase has been completed. The results are being compiled and analyzed, and the report will soon be submitted to Washington for publication. Lack of computational assistance has delayed the completion of this report, and at present it is being held up to give preference to the report on the Reconstruction Phase.

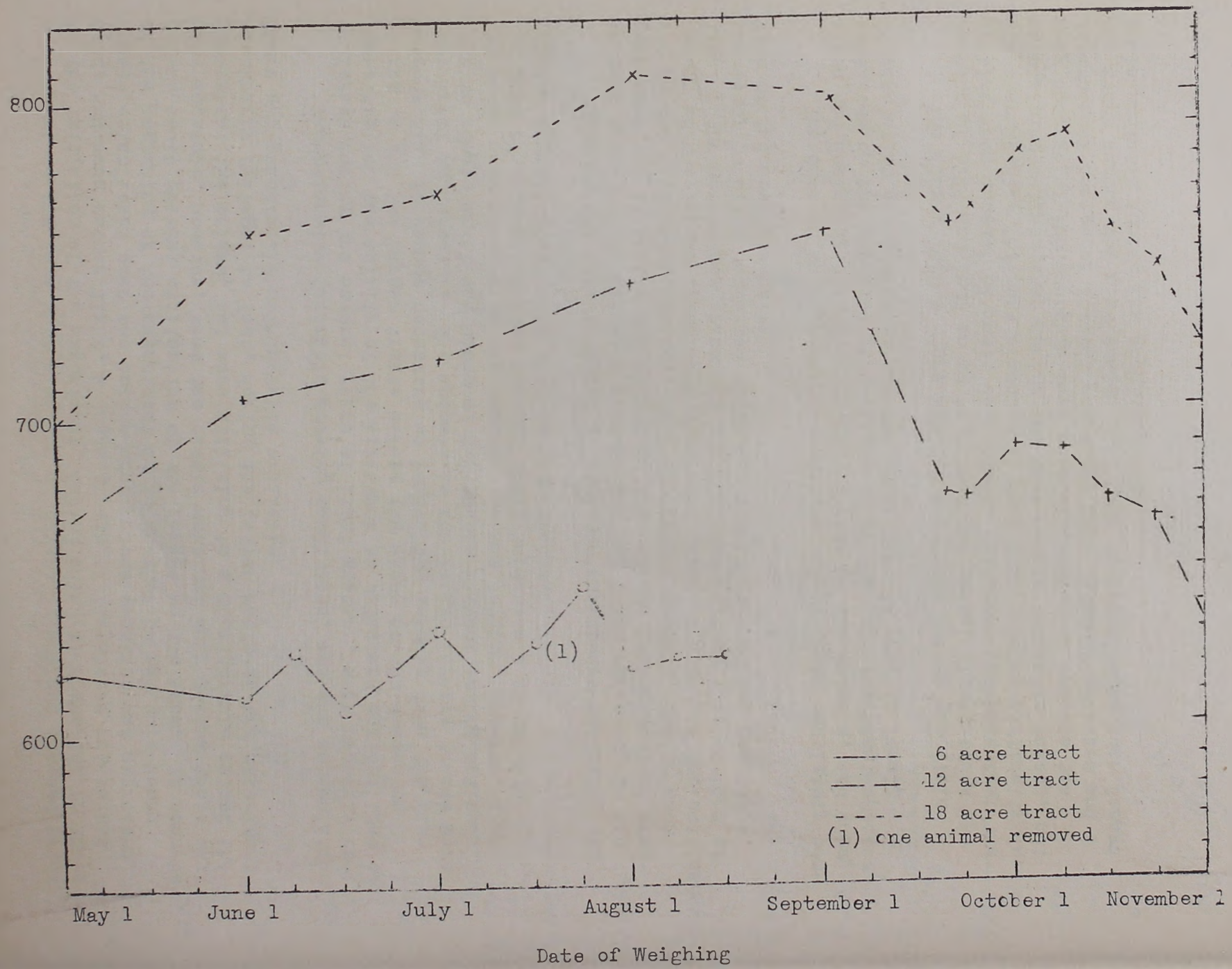
Reconstruction Phase. During the last two years, the principal efforts on the grazing project have been centered in the development of the Reconstruction Phase, to determine the ability of farm woods to regenerate naturally following the removal of live stock. All work so far accomplished has been done in cooperation with the Purdue Agricultural Experiment Station. During the past field season a crew, composed of Daniel DenUyl of the Purdue Agricultural Experiment Station; John Baker, employed temporarily by the Purdue Station; and Oliver Diller, employed temporarily by the Forest Experiment Station; working largely under DenUyl's direction, established 53 permanent sample plots. Most of these plots have been located in woodlands classified under the Indiana Forest Tax Law, which prohibits the grazing of live stock. Twenty-two constitute remeasurements of temporary plots located during the summer of 1930.

A bulletin covering the preliminary results secured from the two years' work on this phase of the study has been practically completed by Day and DenUyl and will be published during the next few months by the Purdue Agricultural Experiment Station, under the title "Studies in Indiana Farm Woods - I - Regeneration of Farm Woods Following the Removal of Livestock."

During 1932 this phase of the study will be carried on in essentially the same manner as it was in 1931. It is planned to remeasure at least 25 of last year's plots, and to establish such new plots as are needed to give a better distribution over the various forest types, crown densities, and forest floor conditions.

Livestock Management Phase. This phase of the study was set up to secure information on the value of woodland pasture in terms of forage acres, and also to investigate the possible methods of livestock management in the farm woods, compatible with the production of timber. During the past season, a preliminary study was initiated under this phase through the cooperation of the Purdue Agricultural Experiment Station, to demonstrate that the farm woods of the Corn Belt are incapable of furnishing any material amount of forage under the very heavy conditions of overstocking which prevails throughout the Corn Belt. A rather open tract of oak-hickory woodland, located on the Pinney-Purdue Farm near Valparaiso, Indiana, was subdivided into three tracts of 18, 12, and 6 acres each. These tracts were fenced off, and three head of yearling steers were placed in each on May 1. They were kept adequately watered and salted, but no supplementary feeding was provided. Regular weighings were made at periodic intervals throughout the six months' grazing season. The final weighings were made on November 1 at which time the livestock were removed from the woods.

Average Weights of Three Animals in each Tract



Due to the fact that a period of several years had elapsed prior to the initiation of the experiment, during which time grazing in these woods had been rather light, a dense growth of blackberry briars had become established over the entire area. Some question was expressed at the beginning of the experiment as to whether or not this heavy growth would prevent utilization of the forage on the area. It soon became apparent, however, that the cattle were not only making their way throughout the briars, but were utilizing to a considerable extent the blackberry foliage; in fact, during the latter weeks of the experiment there was practically nothing else available.

Exceptionally favorable growing conditions, and the accumulation of forage during the several years of light grazing, were probably responsible for the ability of the livestock to withstand serious loss of weight in the two larger tracts before the close of the season on October 31. It became necessary to remove the animals from the six-acre tract on August 1. The animals in the 12 and 18-acre tracts were able to remain until the close of the season without losing entirely the gains made earlier in the summer. It was obvious, however, that the peak of utilization was reached about September 1 as weights rapidly dropped after this date in both tracts.

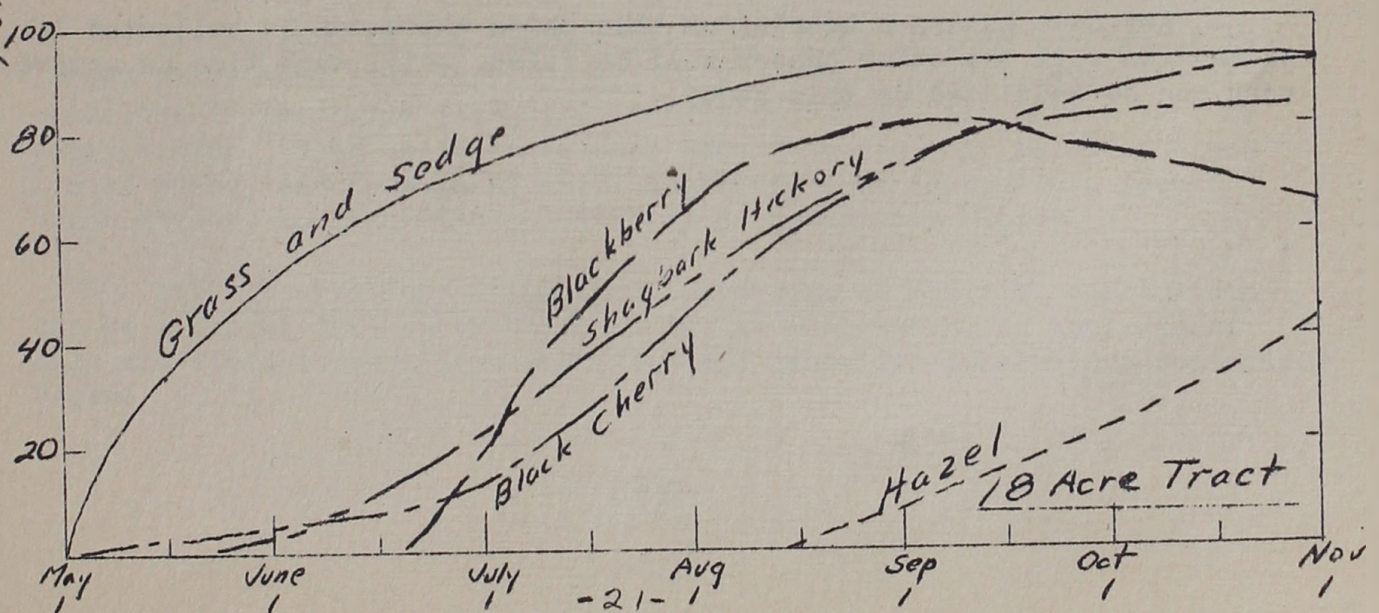
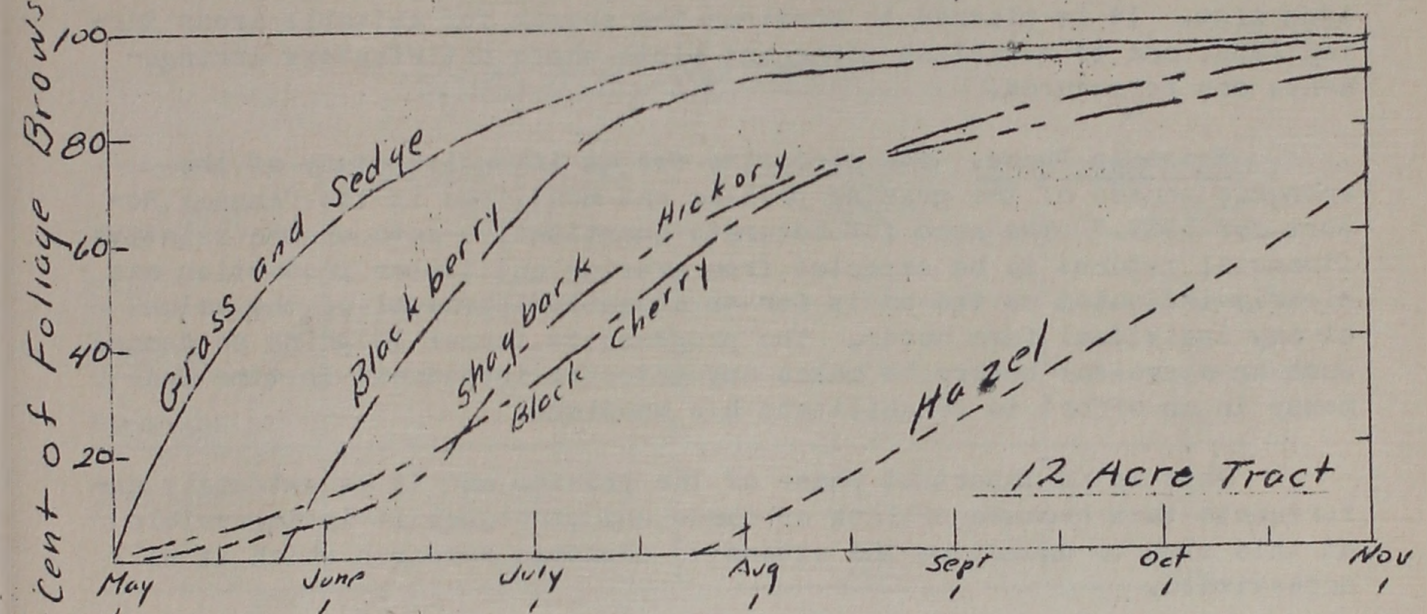
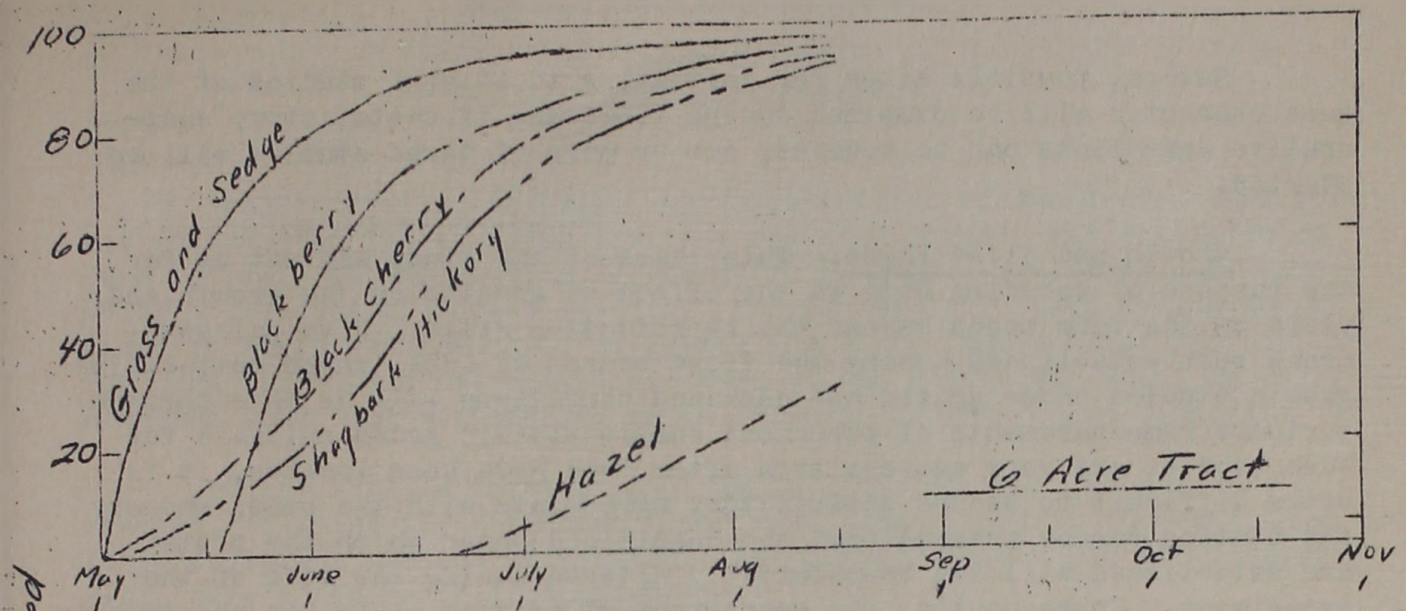
Through the establishment of eighteen rod-square quadrats, six in each tract, three of which were fenced and three unfenced, it has been possible to follow the effect of the various intensities of grazing on the tree reproduction. Four one-meter quadrats, one in each corner of the larger 1/160 acre quadrats, permit a study of the utilization of the herbaceous grass and shrubby vegetation. This portion of the study is being conducted under the supervision of Dr. Stanley A. Cain of Indiana University.

The data on this season's tests have not yet been completely compiled and analyzed, but the periodic weights of the animals, and some estimates on the per cent of utilization of the most important species of vegetation are available and are given here in graphic form.

The Pinney Purdue study will be continued during the field seasons of 1932 and 1933 so as to offset any annual fluctuations resulting from unusual climatic conditions. It seems probable that the livestock during the next season will have much greater difficulty in maintaining weights than during the past rather favorable season, not only because of the probable less rainfall, but also because the accumulated forage of several years has been entirely utilized and the stock during the next season will have to depend upon such forage as is produced during the growing season.

Pinney Purdue Study

Utilization of Principal Species (Estimated in Percent of Foliage Browsed)



Several possible sites for initiating additional studies of the same character will be examined during 1932, and if satisfactory cooperative agreements can be secured, one or more of these studies will be started.

Growth and Yield Phase. This phase of the study was set up for the purpose of securing data on the effect of grazing on the growth and yield of the farm woods beyond the reproduction stage. Five paired areas were established during the field season of 1931, where comparative growth studies under grazed and ungrazed conditions will be made through periodic remeasurements of permanent sample plots. Areas suitable for such studies are very scarce; even after they have been located, it is often difficult to secure satisfactory agreements with the owner whereby the Station can be assured that the conditions under which the plots are established will not be materially altered during the life of the experiment. Consequently, the establishment of such plots has necessarily been slow. It is planned to continue the search for suitable areas during 1932, and to establish permanent plots where satisfactory arrangements can be secured.

Economic Phase. The necessity for an intensive study of the economic phases of the grazing problem was mentioned in the "Annual Report for 1929." The need for accurate quantitative data on the relative financial returns to be expected from grazing and timber production was clearly indicated as the basis for an adequate appraisal of the value of any individual farm woods. The progressive farmer is going to demand such an appraisal before he makes any material investment in time and money in an effort to rehabilitate his woodland.

This is an important phase of the problem and it is extremely unfortunate that because of lack of funds and personnel it is impossible at this time to undertake the extensive economic research which it will necessitate.

Any data having a bearing on this phase which can be collected in connection with the other phases will be filed, until such time as active work can be initiated on this study.

LOCUST BORER INVESTIGATION

(Dr. Ralph C. Hall)
(U. S. Bureau of Entomology)

Project started in 1931. An investigation of the destructive forest insect, the locust borer (Cyrtene robiniae Forst) was initiated on June 1, 1931, at the Station by Dr. Ralph C. Hall, U. S. Bureau of Entomology, Division of Forest Insects. During the 1931 field season he was aided by field assistants G. Z. Rayner and W. G. Cummings for periods of four and six months respectively. Most of the season was spent in Ohio, although some work was carried on in Indiana, Kentucky, and Michigan.

During 1931, a total of 300 sample plots of black locust were studied, of which 180 permanent plots were established in cooperation with L. F. Kellogg's project of planted black locust yield. The 120 temporary plots were established independently.

Locust Borer Investigation - 1931

State	: Permanent Plots : Number	: Temporary Plots : Number	: Total Plots : Number
Ohio	: 144	: 54	: 198
Indiana	: 28	: 19	: 47
Kentucky	: :	: 35	: 35
Michigan	: 8	: 12	: 20
Total	: 180	: 120	: 300

In addition to the sample plot work, life history studies of the locust borer have been carried on. Fall spraying experiments were also conducted to determine the effectiveness of sprays late in the fall or early winter. Seed collections were made from severely infested black locust trees, and from those which appeared to be immune from locust borer attack, to study the possibility of inherent immunity.

1931 Observations Summarized. Although no definite conclusions can be given at this early stage of the investigation, an analysis of data and field observations justifies the tentative conclusions summarized below.

1. A very close relationship appears to exist between site quality and injury by the locust borer. The better the site, the less is the injury.

2. A close relationship appears to exist between crown class and locust borer injury. During the first ten years in the life of a stand, trees in the dominant and codominant crown classes are injured more severely than are those in the intermediate or overtopped classes; but from ten years of age upward, the dominant and codominant trees are least severely injured. In the case of the young stands, it is suggested that the rougher bark of the larger trees may invite attack. Also it is possible that the dominant trees attacked in the young stand become the intermediate or overtopped trees in the older stand, because of borer injury.

3. A close relationship appears to exist between the crown density of a stand, and locust borer injury. The greater the density of shade, the less is the borer injury. In this case it may be that cause and effect are being confused, because borer damage to a stand reduces the crown density.

4. Bark thickness appears to have some bearing upon injury by the locust borer; the thicker the bark in any age class, the less is the borer injury.

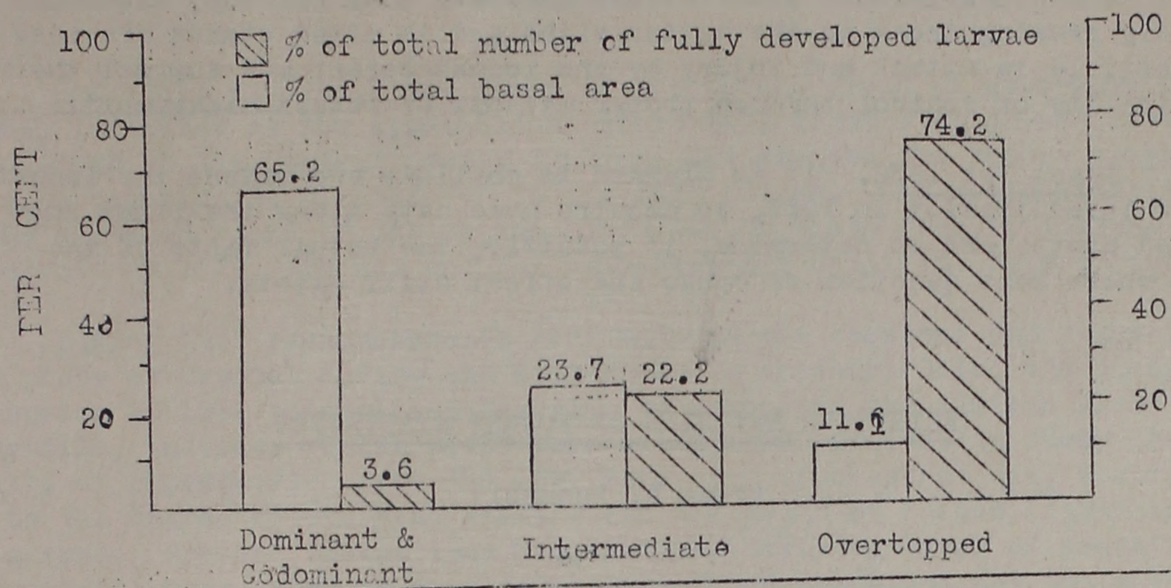
5. Composition of stands appears to have a pronounced effect upon the amount of locust borer injury. Pure stands of locust appear to be much more susceptible to attack and injury than do mixed stands. With the exception of catalpa and locust mixtures, wherein locust is usually badly injured, mixed stands of locust and other species appear to reduce the borer injury to the point where it is of little commercial importance.

6. The relationship of root nodule formation appears to be definitely correlated with borer injury. The greater the abundance of nodules, the less is the injury by borers. In this instance also, cause and effect may be confused.

7. No definite relationship was found to exist between locust borer injury and the following factors: abundance of goldenrod, exposure, slope, density of stand, and acidity (pH) of soil.

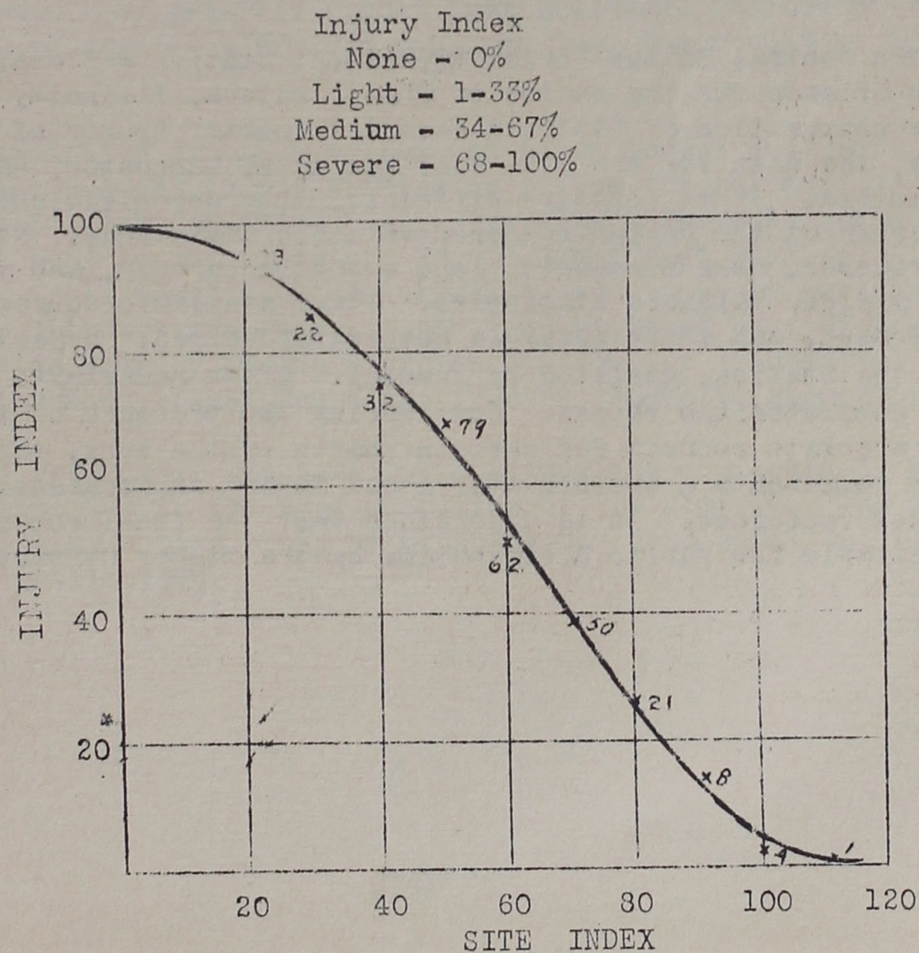
8. It appears that very few larvae of the locust borer are able to reach full development in trees in the dominant and codominant crown classes, and that approximately 96 per cent of all the adult borers produced in a stand emerge from trees in the intermediate and overtopped crown classes.

RELATION BETWEEN THE % OF THE NUMBER OF FULLY DEVELOPED LOCUST BORER LARVAE
AND THE % OF THE TOTAL BASAL AREA, IN EACH CROWN CLASS, IN BLACK LOCUST



RELATIONSHIP BETWEEN SITE AND LOCUST BORER INJURY

Site Classification Age - 50 Years



These preliminary observations indicate that healthy, vigorous, rapidly growing trees on the better sites and in mixed stands are less susceptible to attack and injury by the locust borer; and suggest the possibility of control through proper methods of forest management.

Plans for 1932. It is planned to continue and extend the locust borer investigation in 1932, to acquire more data along the lines suggested above, and to determine, if possible, the actual facts of the case where some question of cause and effect still exists.

EXTENSIVE REVISION OF FOREST STATISTICS

(John G. Kuenzel)

During 1931 the U. S. Forest Service has undertaken the task of assembling and revising data pertaining to forest land area, timber supply, forest growth and drain, for the entire United States. The purpose of this work was to assist the Timber Conservation Board, appointed by the President, to appraise the situation concerning the nation's forest resources, and to make available for general public dissemination the latest forest economic statistics.

The Central States Forest Experiment Station was assigned the compilation of data for the states of Ohio, Indiana, Illinois, and Iowa; with the cooperation of District Forest Inspector Bruner of Louisville, Kentucky, the data for the states of Kentucky, Tennessee, and Missouri were compiled. State forestry officials, many organizations, and individuals throughout the region rendered valuable assistance. State and county records, census reports, land economic surveys, and various public reports yielded valuable statistics. Every available source of information was used, and every possible cooperator helped. McCarthy headed the work of the Station, assisted by Kuenzel. After McCarthy's resignation, Kuenzel completed the report. Considering the pressure of time and the lack of accurate records for certain phases of the work, this extensive revision represents a decided step ahead toward an accurate appraisal of our forest resources. It is understood that the final report will be made available for public distribution by the Timber Conservation Board.

MISCELLANEOUS

Oak Yield Studies. The study of growth and yield of even-aged oak stands, initiated at the Appalachian Forest Experiment Station and later transferred to the Central States Station, has reached the report stage, and a publication is planned for in the near future. The plots established in the all-aged stand of oak on the Clark County State Forest, Indiana, by Barrett in 1929, are not due for remeasurement until the fall of 1934.

During 1931 remeasurements were made of the chestnut oak regeneration plots at Crystal Spring and Rock House in southern Ohio, and during the spring of 1932 Kuenzel and Day plan to remeasure the similar plots at Henryville, Indiana. These plots were established in 1929 to study the results of reproduction from the 1928 seed crop of chestnut oak, according to the degree of overhead shading and the depth of forest litter on the ground. Present indications are that the early survival of seedlings is greatest where there is considerable overhead shade and not too much leaf litter.

Seed. The abundance of seed of most hardwood species during 1931, following the abnormal drought of 1930, has been observed and reported by Day and other members of the Station's staff. Botanists at Ohio State University have expressed the opinion that changes in the carbohydrate-nitrogen ratio may very possibly result from prolonged periods of drought, and that the heavy seed crop of 1931 may have been the result of such a change.

Small quantities of black walnut and black locust seed were gathered by Kellogg at the request of the Washington office for shipment to a former Governor of the Province of Entre Rios, Argentina. Three kilograms of butternuts were sent to the Director, Forest Experiment Station, Kiejo, Chosen, Japan. Small quantities of butternuts and buckeyes were sent to a cooperator in southwestern Ohio. A small quantity of seed of black locust was sent to Wakeley at the Southern Station for transmittal to Dr. Rudolf Fleischmann, Plant Breeding Director, Kompolt, Hungary.

Finished Projects. The Forest Type study was completed by McCarthy, and a report submitted to the Type Committee of the Society. The manuscript of the Yellow Poplar study by McCarthy has been submitted to Washington for publication.

Publications

The following articles and reports by members of the Station's staff have appeared during the past year.

"Destructiveness of Grazing to the Farm Woods" -- R. K. Day. ✓ 30
Purdue Agriculturist - October, 1930.

"Possibilities of Fire Extinguishing Chemicals in Fighting Forest Fires" -- L. I. Barrett. ✓ 31
Journal of Forestry - February, 1931.

"The Central Hardwood Forests - A Research Task" -- E. F. McCarthy. ✓
Proceedings of the First Central States Forestry Congress - 1930.

"What Species Shall We Plant" -- L. F. Kellogg. ✓ 30
Proceedings of the First Central States Forestry Congress - 1930.

"Protection From Grazing is Essential to the Welfare of Farm Woods" -- R. K. Day.
Proceedings of the First Central States Forestry Congress - 1930.

"A Soil Study of the Mont Alto State Forest" -- J. T. Auten. X
Pennsylvania Dept. of Forests and Waters, Research Bulletin 4. not ours

The following reports have been submitted for publication:

"Yellow Poplar - Its Characteristics, Growth and Management" -- E. F. McCarthy.
U. S. Forest Service.

"Porosity and Water Absorption of Forest Soils" -- J. T. Auten.
U. S. Forest Service.

"Spacing and Mixtures in Forest Plantations" -- W. M. Baker.
Journal of Forestry.